SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1903.

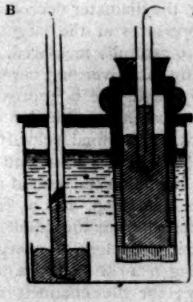
GENERAL PHYSICS.

531. *Some Characteristics of the Flow of Water in Channels of Varying Cross-Section.* **T. E. Stanton.** (Engineering, 74. pp. 664 and 666, Nov. 21, 1902.) —It was formerly assumed that the loss of head due to friction is the same for a given pipe AB whether the flow be from A to B or B to A, provided that the quantity of flow is the same in the two cases. Reynolds, however, has demonstrated that the loss of energy due to friction is considerably greater in the diverging direction of the tube than in the converging. The object of the author's experiments was to obtain information on (1) the effect of the form of the channel, and (2) the effect of the angle of divergence on the loss of head involved. The first observations were made on a channel of circular section, 4½ in. long, the diameter decreasing from ¾ in. at one end to ¼ in. at the other. The pressures at the largest and smallest sections for given velocities of flow were carefully measured. The author finds that the loss of head of water flowing as a diverging current to a state in which the kinetic energy is practically negligible is approximately 25 per cent. of the initial velocity head, and that when the direction of flow is reversed the loss is approximately 10 per cent. of the final velocity head; those ratios are the same for the range of velocity 11 ft. per second to 30 ft. per second at the least section. In the experiments on the second point, the diverging channel was of rectangular section, ⅜ in. deep, and at the widest part 2 in. broad. The losses of energy calculated from the results show that in a diverging channel of rectangular section the loss of energy is nearly constant for all angles of divergence ranging from 2° up to a certain limiting value, after which it increases rapidly; for the channels used the limiting angle is about 6°. For diverging flow in the first (circular) channel, the coefficient of friction is about four times its value for a parallel channel. Finally the author applies his results to the consideration of flow past ship-shaped forms. Complete tables of results are given throughout. W. S.

532. *Vortex Motion in a Liquid.* **C. W. Oseen.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. 59. No. 9. pp. 289–309, Nov., 1902.)—In this paper the author considers the motion in an ideal liquid, extending infinitely in all directions, on the hypothesis that this motion is free from any vortices, except for a thin helicoïdal vortex thread. This problem is interesting on account of the analogies it offers in all essential points with both of the classical cases of vortex motion, *i.e.*, the case of either a rectilinear or a circular vortex thread being exclusively present, and because this is the only case of such a motion comparable with the above. The phenomena connected with this motion, moreover, deserve considerable interest in themselves. A. G.

533. *Surface-tension and Double-layers at the Boundary of two Solvents.* **F. v. Lerch.** (Ann. d. Physik, 9. 2. pp. 434–441, Sept., 1902.)—The surface-tension at the boundary of benzene and water is $\alpha = 32{\cdot}8$; this is decreased by the addition of acetic, hydrochloric, or picric acids, and by sodium hydroxide or ammonia, but sodium chloride and sodium acetate produce little or no effect. On gradually neutralising ammonia with acetic, hydrochloric or picric acid the surface-tension reaches a minimum in neutral solution, but a maximum surface-tension is reached when sodium hydroxide is neutralised by hydrochloric or acetic acid. The author thinks that these changes are due to electrical causes. Similar observations were made with a capillary electrometer. T. M. L.

534. *Capillarity of Solutions.* **J. Mathieu.** (Ann. d. Physik, 9. 2. pp. 340–366, Sept., 1902. Abstract of Bonn Dissertation.)—A membrane when immersed in a solution becomes saturated with a more dilute solution, and may even by absorption of water bring about crystallisation of the solution. The same law holds good in the case of other capillaries, and it is therefore not possible to determine the surface-tension of a solution by observing the height to which it rises in a capillary tube, as the solution in the tube is more dilute than the bulk of the liquid. The strength of the solution in the capillaries can be determined by a concentration-cell method.



In the apparatus shown in the Figure the electrode B is connected to a 3 per cent. cadmium amalgam in contact with a cadmium sulphate solution, whilst the electrode A dips into a similar amalgam which is in contact only with the cadmium sulphate in the pores of a membrane or porous pot. Using a porous pot the e.m.f. observed was 0·00030 volts, and the concentration in the pores of the pot 0·96 of the concentration of the solution; other experiments gave voltage 0·00025 and 0·00028 and concentrations 0·96 and 0·97. A porous plate of Pukall-ware gave concentrations 0·63, 0·64, and 0·76 in three experiments. Parchment paper gave in three experiments the concentrations 0·10, 0·30, and 0·12, whilst bladder gave concentrations 0·06, 0·39, and 0·10, the values differing widely with the piece used. Similar experiments were then made with a single capillary aperture, using a solution of $HgNO_3$ containing 137·3 g. per 1,000 c.c. of water, and pure mercury electrodes. The radius of the capillaries was determined (*a*) by measurement with a microscope, and (*b*) by measuring the electrical resistance of the mercury thread in the capillary. The following results were obtained :—

Radius.		E.M.F.	Concentration.
(*a*) 0·01240 mm.	(*b*) 0·01227 mm.	0·0026 volts	0·39
0·00765 „	0·00762 „	0·0084 „	0·80
0·00966 „	0·00979 „	0·0042 „	0·23
0·00920 „	0·00925 „	0·0054 „	0·15

The concentration, with the exception of that in the second capillary, decreases regularly with the radius of the capillary. Observations were also made with a modified apparatus in which the capillary was filled with solution and dipped into a dish of mercury. Using one capillary throughout the values found for the concentration in the capillary were steady at (1) 0·71 with the strong mercurous nitrate solution, (2) 0·82 with a solution half as strong, (3) 0·90 with a solution one-third as strong. T. M. L.

535. *The Eruptions of La Soufrière, St. Vincent, and Mt. Pelée, Martinique, 1902.* **E. O. Hovey.** (Amer. Journ. Sci. 14. pp. 319–358, Nov., 1902. Abstract of Preliminary Report, published in the Bulletin of the American Museum of Natural History, vol. 16, pp. 333–372.)—La Soufrière, like the whole of St. Vincent, is made up of ancient lava flows and volcanic deposits or tuff agglomerates. The author was the first to ascend the volcano on May 31, after the eruption of May 8. The eruption did not start from the crater of 1812; the saddle between the two craters was intact. There was no stream of molten lava, but the deeply cracked "bread-crust" bombs of andesitic lava must have been ejected in the half-molten state; there was a hurricane blast of steam-laden dust radially from the crater. The dust did not contain any chlorine (W. F. Hillebrand); this points to fresh water as the source of the steam. The heat retained by the enormous masses of dust, and the rains, caused secondary eruptions and mud-flows; there were no mud craters. Cellars with heavy wooden shutters over the windows proved the only safe refuge.

On Martinique a "breadcrust" bomb, 22 × 24 × 30 ft., was found. The trees and walls had distinctly fallen radially to the crater. Mt. Pelée was ascended four times in six weeks. The author was once surprised by a torrent of water, black with ashes, which followed an eruption after heavy rains; but the general sequence of the events is not clear. The mud-flow of May 8, *e.g.*, preceded the great eruption by four hours. The destructive steam-blast which descended from the crater was probably dark; the flames were local and due to incandescent lapilli. The paper is illustrated by nineteen photographs. H. B.

536. *Ocean Currents and Winds.* **J. Page.** (Monthly Weather Rev. 30. pp. 397–401, Aug., 1902.)—The author believes that the ocean currents may largely be due to winds, especially to the trade winds, though the downward propagation of currents in water is exceedingly slow. At the Adlergrund

lightship in the Baltic, a change in wind direction is not felt at a depth of 2¾ fathoms until after an interval of twenty-four hours. The paper refers more particularly to the three ocean currents in the equatorial regions and the Gulf Stream, and further to the uncertainty of current charts based upon uncertain positions, determined by dead reckoning. The Philadelphia Geographical Society has distributed fifty casks among whalers to be placed on the ice as far eastward as possible in the Arctic Ocean; and the British Lloyd will explore the currents off Ushant and Cape Finisterre by means of sealed guttapercha bottles. H. B.

537. *Statics and Kinematics of the Atmosphere. Cosmical Meteorology.* **F. H. Bigelow.** (Monthly Weather Rev. 30. pp. 347–354, July, 1902.)—The author wishes to establish synchronism between the variation of sunspot numbers and amplitude area numbers (Wolfer's Tables), and terrestrial magnetic force and meteorology. As regards the magnetic elements, he confines himself to the variation in the horizontal force, as shown by the 24-hourly means, for the period 1841 to 1899, which he divides into five periods of 11 years; the data are taken from the observatories of the entire globe. The curves bring out clearly (1) the 35-years' period, with maxima in 1855 and 1890, and minima in 1868, and probably also in 1838 and 1903; (2) the 11-years' period in exact synchronism with the horizontal force; (3) superposed upon the latter curves four minor crests pointing to a period of 2¾ years. The author further considers the solar prominence curve (Tacchini-Lockyer) and the magnetic horizontal force curve to be in synchronism. The study of barometric pressure variations in 1873 to 1899 again concerns the whole world; his curves represent annual variations from mean annual pressures. If all the positive values are added for each year, and all the negative values likewise, those two curves do not cancel one another, but both are said to match the prominence curve fairly well. This is assumed to establish that some external force raises and lowers the atmospheric pressure by a small amount from year to year. The synchronism with the prominence curve is close for India and South-east Asia, irregular for Europe and the United States, and distinctly resumed (but reversed, as referred to India) for South America.

H. B.

538. *Lowne's Electrical Recording Vane and Anemometer.* (Electrical Times, 22. pp. 718–719, Nov. 13, 1902.)—This instrument is operated by an eight-day clock and by four Leclanché cells. The 2-in. wide recording strip has four longitudinal rows of holes corresponding to four points of the compass, the intermediate spaces and the space beyond on one side corresponding to four additional points. A transversely stepped line indicates the direction of the wind. The speed of the wind is measured by forming a long transverse line in one direction at the termination of each mile of wind, and a short transverse line in the other direction at the termination of each one-tenth of a mile, so as to form a continuous stepped line, which extends near a longitudinal row of holes punched by the clock every ten minutes. Two photographs are given of the mechanism, but no technical description.

C. K. F.

REFERENCE.

539. *Meteorological Observations made at Geneva and Grand Saint-Bernard during September*, 1902. (Archives des Sciences, 10. pp. 453–460, Oct., 1902.)

LIGHT.

540. *Theory of the Welsbach Gas Mantle.* **M. Solomon.** (Nature, 67. pp. 82–84, Nov. 27, 1902.)—The author reviews the work of several recent investigations on this subject, and concludes that the light emitted is due partly to good radiating power, partly to the high temperature attained by the substance of the mantle, and partly to selective emissivity. Armstrong, Welsbach, and others consider that the luminosity is due to chemical changes of an oscillatory nature, which take place in the substance of the mantle, the ceria molecules probably oscillating between a lower and a higher state of oxidation. Welsbach holds that in one or other state of oxidation ceria forms a compound with thoria; reactions of various kinds occurring several million times a second cause molecular shocks, which in their turn give rise to luminous oscillations. Swinburne considers that the light is merely a high temperature effect, a certain quantity of ceria being necessary to increase the radiating power of the mantle. Le Chatelier and Nernst have shown that the emissivity is poor in the region of the red rays, and this tends to raise the temperature of the mantle, which according to Bunte is higher than that of the flame. White, Travers, and Russell have estimated the temperatures by means of thermopiles, and find the mantle to be slightly below the temperature of the flame, a mantle composed of pure thoria being slightly hotter than one composed of 99 per cent. thoria and 1 per cent. ceria. W. H. S.

541. *Simple Apparatus for Observing Diffraction Phenomena.* **G. Foussereau.** (Journ. de Physique, 1. pp. 642–643, Oct., 1902.)—This apparatus may be constructed by laboratory students with simple materials. It consists of two metal tubes, one sliding in the other. A metal plate with a small central hole or slit is mounted on a cork ring inserted in the outer end of the larger tube. A low-power eyepiece mounted in cork is inserted in the small end, to serve for projecting images on a screen at a distance of from 6 to 30 cm. Between the two a smaller hole or fine slit may be mounted on another cork to show diffraction fringes. A needle, or the straight edge of an opaque object, may be mounted in conjunction with it to show shadow phenomena. Cork rings are inserted in the tubes to intercept light reflected from the sides. A. E.

542. *Calculating e/m from Magnetic Rotation.* **L. H. Siertsema.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 499–502, Dec. 27, 1902.)—On the simple explanation of magnetic rotation, as given by FitzGerald [see Abstract No. 756 (1898)], by means of the Zeeman phenomenon, Hallo establishes for the magnetic rotation ω the formula $\omega = 2\pi/\lambda \,.\, z\delta\, dn/d\lambda$. Here it is assumed that the effect of the magnetic force consists only in displacing the dispersion curve, $n = f(\lambda)$, of a medium over a distance δ, and the formula is relative only to parts of the spectrum situated in the neighbourhood of an absorption band. The author applies this formula to the points situated far away from an absorption band, such as is the case with the magnetic rotation of transparent substances. As in the slightly modified formula given by Siertsema, the ratio e/m occurs, it is suggested to make use

of this relation in order to calculate this ratio for substances with given constant rotation and dispersion. This method is applied to the cases of atmospheric air, carbonic acid, hydrogen, water, carbon sulphide, and quartz, the values found being of the order of 10^7, *i.e.*, in perfect accord with those determined by other methods. A. G.

543. *The Spectrum Place of the Sodium Lines in Different Azimuths.* **C. Piazzi Smyth.** (Roy. Soc. Edinburgh, Proc. 24. pp. 225–232, Nov., 1902.) —The paper describes a series of experiments undertaken to investigate whether the position of the lines alters in different azimuths. A Rutherford grating was used with a ruled surface of 1·6 sq. in. and 17,296 lines to the inch. No variation could be detected. E. C. C. B.

544. *Fluorescence of Diamonds.* **O. Rosenheim.** (Chem. News, 86. p. 247, Nov. 21, 1902.)—The paper describes experiments on the action of the rays emitted by radio-active polonium upon diamonds. Fluorescence was induced in the diamonds when exposed to the influence of the polonium in the case of all the specimens examined. The rays given out by the diamonds also affected the photographic plate, and exhibited a power of penetrating various substances which was not shown by the rays from polonium. Certain diamonds were found to phosphoresce after exposure to magnesium light, but the rays they gave out did not affect the photographic plate. J. J. S.

REFERENCES.

545. *Lens-curve Tester.* **G. Halle.** (Zeitschr. Instrumentenk., Beib. 15. pp. 142–143, Aug. 1, 1902.)—Description of instrument with drawing; a kind of spherometer with lever and scale-reading for measuring curvatures. A. D.

546. *Vision at a Distance by Electricity.* **J. H. Coblyn.** (Comptes Rendus, 135. pp. 684–685, Oct. 27, 1902.)—The transmission is effected by the selenium cell, and the object of the note is to indicate an arrangement of lenses and rotating cylinder pierced with helicoidal holes, by which the exploration of the image can be effected. A detailed description of the apparatus will be given later. J. W. P.

547. *Properties of Pleochroitic Crystals.* **W. Voigt.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 269–277, 1902.)—A somewhat novel mathematical treatment is followed, in which the reflected wave is taken into account, and the treatment is confined to the parts surrounding the "Windungsaxen" on account of an anomalous result obtained, the Windungsaxen being directions in the crystal in which the two elliptical vibrations [see Abstract No. 211 (1903)] are turned into circular ones. G. E. A.

548. *Becquerel Rays and Radio-active Substances.* **F. Giesel.** (Zeitschr. Elektrochem. 8. pp. 579–585, Aug. 14, 1902. Paper read before the German Electrochemical Society at Würzburg, May 9 and 10, 1902.)—A brief summary of the facts known. R. S. W.

549. *Radium and Radio-active Substances.* **F. Giesel.** (Chem. News, 86. pp. 250–251, Nov. 21, 1902. From the Berichte, 1902, 35, 3608.)—Observations on the chemical behaviour and radio-active properties of various salts of radium, polonium, and other radio-active bodies. J. J. S.

HEAT.

550. *Heat-resistance.* **W. Kent.** (Amer. Soc. Mech. Engin., Trans. 24. No. 0955. pp. 1–8, 1902.)—The author insists on the advisability from the practical point of view of adopting Rankine's suggestion that, in place of heat-conductance and coefficients of conductivity, we should consider their reciprocals, heat-resistance, and coefficients of resistance. All formulæ are thereby simplified. R. E. B.

551. *Freezing-point of Water and of Aqueous Solutions under Pressure.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 316–332, 1902. From the Physik. Kabinet der k. k. Universität in Wien.)—By means of an electrical-resistance thermometer the depression of the freezing-point of water was found to be 0·00747° C. per atmosphere, up to 100 atmospheres. Kelvin's original value was 0·0081°, whilst Dewar, who exposed his thermo-element to the pressure of the liquid, obtained the value 0·0072°; the theoretical value 0·00752° agrees very closely with that now determined: The constant for a solution of 0·3 g. NaCl in 100 c.c. H_2O was 0·0090° C. per atmosphere, and that for a solution of 342 g. cane sugar in 100 c.c. H_2O 0·00886° C. per atmosphere, values considerably greater than those for pure water. T. M. L.

552. *Freezing-point of Dilute Solutions of Mixtures.* **Y. Osaka.** (Zeitschr. Phys. Chem. 41. pp. 560–564, Sept. 5, 1902. From the Institut für Physikalische Chemie an der Universität Göttingen.)—The freezing-point was determined of solutions of potassium sulphate and sodium chloride at dilutions from about 100 to 1,000 litres per gram-molecule in water and in solutions containing mannitol, urea, and phenol in the proportion of about 1 gram. mol. in 40 litres. The depression of the freezing-point was nearly equal to that calculated from a simple law of mixtures, but was usually slightly less, especially in the case of the phenolic solutions. An opposite effect has been observed by Rothmund and Wilsmore in determining the influence of phenol on the solubility of potassium sulphate, but these observations were made in very concentrated solutions. [See Abstract No. 1730 (1901).] T. M. L.

553. *Heat of Evaporation and Size of the Molecules of a Fluid.* **H. Mache.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 382–393, 1902.)—The author considers the consequences of treating the vapour-molecule, as well as the fluid-molecule, as a small drop of fluid, or molecular-aggregate in which the internal forces produce a surface-tension whose coefficient is equal to the normal surface-tension of the fluid in question. The heat of evaporation is then calculated by determining the work done in separating the vapour-molecule from the fluid-molecule and adding it to the work done against external pressure. The resulting formula $L = p(w - \omega) + 4N\rho^2\pi a - 2\omega a/r$, where p and w are the pressure and specific volume of the vapour, ω the specific volume of the liquid, N the number of vapour-molecules in unit mass,

ρ and r the radii of the vapour and fluid drops, and a the capillary constant, or $L = L' - 2\omega a/r$, where L′ is the value of the heat of evaporation when the fluid-molecule is very large, shows, if the fluid be not near the critical state, the dependence of its heat of evaporation on the radius of its molecule (*cf.* Houllevigue Physical Society, Abstract No. 401, 1896). The theory further leads to the potential energy of a fluid being equal to its kinetic, and therefore, for a monatomic vapour, to the total energy of the fluid being twice the kinetic energy of the vapour, which is verified for mercury as the specific heat of the fluid is twice that of the vapour; r and ρ are calculated for various fluids and, under certain assumptions, the laws of Trouton and Tumlirz relative to the heat of evaporation of fluids (see Akad. Wiss. Wien, Sitz. Ber. 101, p. 184, 1892) are deduced. W. E. T.

554. *Vapour Density of Metallic Vapours.* **F. B. Jewett.** (Phil. Mag. 4. pp. 546–554, Nov., 1902.)—To determine the effect of pressure and temperature on the broadening of the spectral lines, a knowledge of the densities of the saturated vapours at various temperatures is necessary. This is also important in connection with the Zeeman effect. The method is to find the amount of condensed metal in the observing flask (of known volume) after the latter is cooled off. The apparatus consists of this flask, a heating bath, and a thermometer. The flask was about 2,000 c.c. capacity, and was provided with two tubes, one a heavy capillary for sealing off after exhaustion, the other, of 1 cm. bore, to carry the metal to be vaporised. The experiments were carried on in the range 350° to 450° for sodium, and the density as found varies from ·000,000,09 to ·000,007,5. The experiment was also performed for mercury from 40° to 325° and the results compared with those of Regnault and Hertz, and of Ramsay and Young. The special electric heating bath used, keeps the temperature constant to within 1 or 2 degrees. A platinum thermometer is employed. J. W. P.

555. *Radiation of Heat and Light from Heated Solid Bodies.* **J. T Bottomley.** (Phil. Mag. 4. pp. 560–568, Nov., 1902.)—This continuation of previous work [see Abstract No. 1818 (1900)] deals with a comparison of the energies required to keep a bright and a black surface radiating so as to present the same colour appearance. Platinum strips were used in a carefully maintained vacuum, and the heating is done electrically. The energy supplied is measured by the current and potential difference, and so an absolute value of the emission per sq. cm. is obtained. This emission is found for conditions of luminosity ranging from grey light to nearly white light, and is always much greater for the black than for the bright strip, *e.g.*, dull red condition, bright strip 0·106, black strip 0·676; nearly white light, bright strip 0·742, black 3·01. The watt-ratio for the two strips under similar conditions of luminosity ranges from 7·85 at grey light to 4·06 at white. A curve of this watt-ratio against temperature (400° to 900°) is given. J. W. P.

556. *van der Waals' Theory of Cohesion-Pressure.* **O. Tumlirz.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 524–552, 1902.)—While deducing van der Waals' equation from general considerations [see also Abstract No. 856 (1902)] the author shows that a different value is obtained for the term representing the cohesion-pressure, according as the substance be supposed uniformly distributed through space or to be a system of uniformly distributed particles, as on the latter hypothesis a surface particle is subject to the action

of more than half as many particles as act on an interior particle. The resulting term is found approximately to be of the form—

$$\frac{\mathrm{K}}{v^2}\left(1-\sqrt[3]{\frac{b^3}{4\sqrt{2}\,v^3}}\right)$$

where K is a function of the temperature, instead of the $\frac{a}{v^2}$ of van der Waals. The corresponding formula is found to agree well with Battelli's observations on CS_2 at both low and high temperatures. So also the fact that K is a function of the temperature instead of a constant is found to harmonise the calculated values of the internal latent heat of evaporation with Zeuner's observed values. W. E. T.

557. *Melting-Curves of Solid Alloys and Amalgams.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 478–485, Dec. 27, 1902, and pp. 576–591, Jan. 31, 1903.)—In the first paper it is shown that when expressing the molecular potential of the tin in a liquid tin amalgam by means of the formula—

$$\mu_1=f(\mathrm{T})+\mathrm{RT}\log(1-x)+(a_1x^2+\beta_1x^3+\ldots),$$

a very satisfactory connection may be established between the values of the melting temperatures, as derived from this formula, for different values of x and the temperatures *observed* by van Heteren at the least up to about 80° C. Now, as the attention of the author has since been drawn to an expression of the correction term in μ_1, developed by van der Waals in 1891, he, in the second article, endeavours to deduce this expression—$a_1x^2/(1+rx)^2$—by a rigorous theoretical method. This point is of peculiar interest, as in a great number of formulæ—for depressions of freezing-points, rise of boiling-points, alterations of vapour pressure, &c.—the same important quantity $\mu_1-(\mu_1)_{x=0}$ always occurs. If, therefore, this quantity be once for all accurately known, the knowledge of a great number of problems in connection with binary mixtures will be greatly advanced. After showing that the theoretical formula is in excellent accord with van der Waals' expression, the author proceeds to discuss the atomicity of tin and mercury on the melting-curves of their amalgams, it being shown that the molecules of both metals are most likely made up of several atoms. A. G.

558. *Conditions necessary for Equipartition of Energy.* **J. H. Jeans.** (Phil. Mag. 4. pp. 585–596, Nov., 1902.)—The author proposes to give a proof of Boltzmann's law of equipartition from a new point of view, and also to examine the precise conditions under which equipartition will take place. A "system" is defined by the n coordinates $q_1\ldots q_n$ and momenta $p_1\ldots p_n$, *i.e.*, $2n$ variables. And we are to suppose a great number of such systems exerting no mutual influence upon each other. The Author introduces now the conception of $2n$ dimensional space, in which he finds it easier to think than in the multiple integrals usually employed in analysis. And he obtains, for his ensemble of systems so defined, relations analogous to the usual relations of hydrodynamics. The number of systems whose coordinates are within the limits $q_1\ldots q_1+dq_1$, &c., is $f dq_1\ldots dp_n$. It is called the density at the point $q_1\ldots q_n$, and is denoted by ρ. The condition for the steady state is found to be $\Sigma_1^{2n}\frac{d\rho}{d\xi}\frac{d\xi}{dt}=0$, where ξ is one of the $2n$ variables. Hence there are $2n-1$ equations of the form $\psi=$ constant, and one other, namely, $\psi_{2n}=$ constant + $f(t)$, which determines the motion along the stream lines. One solution is $\rho = \phi(E)$, where E is the total energy. And this leads to equipartition; but it is not the only solution, and does not prove equipartition. He then considers the Maxwell-Rayleigh proof of the law (Phil. Mag., Jan., 1900), in which it is assumed that by external agencies each system is made to pass through *all* phases consistent with the conservation of energy. He does not accept this proof, because, for reasons given, no system satisfying this condition exists in nature. If the system is to pass through *all* phases, there is no such system; if not through *all* phases, there is no proof. He then assumes his systems to be gas molecules, between which encounters take place. We have, then, thrown overboard the condition of no mutual influence, but the encounters are first supposed to be binary. A molecule while not in encounter is in $2n$ dimensional space, and the density for that space is ρ. Two molecules while engaged in encounter are in $4n$ dimensional space, and the density therein is σ. To find the relation between ρ and σ, he says, we must make Boltzmann's assumption that the motion is "*molecular ungeordnet*," but he does not say what he understands by this phrase, or where and how the assumption affects the argument. Boltzmann, however, in fact, assumes as follows: Let the number per unit volume of molecules 'm' whose variables lie between $q_1 \ldots q_1 + dq_1$, &c., be $f dq_1 \ldots dp_m$, or the chance that this shall be the case for a molecule m is proportional to f. Similarly for a molecule m' it is proportional to f'. And the fundamental assumption in Boltzmann's theory is that the chances are under all circumstances independent, so that ff' represents the number of encounters which take place per unit time between pairs of molecules one from each of the two classes. And if F_1F' denote the corresponding chances for the states in which the molecules find themselves after encounter, we have $ff' = FF'$. This is "*molecular ungeordnet*" in a questionable shape. On this narrow foundation Boltzmann establishes the law of equipartition, and the H theorem, and all the lofty superstructure thereon erected. The Author makes (equation 18) the same fundamental assumption of independence, and obtains, therefore, the same results (equation 19, &c.). He has obtained them by a method probably more elegant, possibly even more general, than Boltzmann's, but logically the same. He concludes, on the above assumption, that if Boltzmann's law does not give the steady state, there must be some other variables besides density and temperature, a knowledge of which is necessary to determine the physical state of a gas, which he does not admit to be possible. Also that in nature a gas cannot attain the steady state owing to the interaction between ether and matter. S. H. B.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

559. *Atmospheric Electricity.* **V. Conrad.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 333–344, 1902. From the Physikalisch-Chemischen Inst. der k. k., Universität in Wien.)—Flames are good discharging electrodes: slow matches act too slowly and the ash disturbs the results. A cigar with ash and the same freshly blown clear differ by 9 volts. *Ibidem*, pp. 341–344; a dense cloud, in which we can only see objects at 18 m. distance, contains 5 grammes of water per cubic metre. Calculating from this it is found that uncharged clouds alter the potential slope between them and the earth only by 0·002 per cent. Calculations as to the effect of charged clouds, which agree very closely with the average results of observation. A. D.

560. *Diurnal Variations in Conductivity of Atmospheric Air.* **H. Nilsson.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. 59. No. 7. pp. 243–249, Sept., 1902.)—The author has made a series of experiments on the diurnal variations in the conductivity of atmospheric air during the months of April and May, 1902, at the Upsala Physical Institute, using simultaneously the Elster and Geitel dispersion apparatus and the aspiration apparatus as constructed by H. Ebert. A most noticeable maximum would be observed toward midnight, the more striking as the sky was brighter at and after sunrise. The rate of discharge for negative electricity turns out to be little superior to the one corresponding to positive electricity. The greatest and most regular diurnal variations were obtained during typical anticyclonic weather. In the case of the sky being bright, the increase will start some time after sunset, and go on as far as midnight, when the conductivity is about twice the value corresponding to noon; as a rule, it will attain values never reached during the day. After sunrise it first increases for a while—possibly on account of the ascending air currents—then keeps practically constant all day. At or immediately after sunset, the author frequently happened to observe a slight minimum. A. G.

DISCHARGE AND OSCILLATIONS.

561. *Current Density at the Kathode in the Electric Discharge in Air.* **H. A. Wilson.** (Phil. Mag. 4. pp. 608–614, Nov., 1902.)—The area covered by the kathode glow is shown to be proportional to the current. The kathode consisted of a straight wire fixed along the axis of a discharge tube 3 cm. diameter, 30 cm. long. The length of this wire covered by the glow was measured and the corresponding value of the current. A disc anode, exhaustion apparatus, &c., complete the arrangement. The glow which envelopes the free end of the kathode wire has the shape of a test tube. Its length is measured on a mm. scale on the tube. For a kathode of wire 1·42 mm. in diameter, and a pressure 5·1 mm. of mercury, the length of the glow ranges from 5·35 to 1·6 cm. corresponding to currents 7·36 to 0·54 milliamperes. The current density per unit pressure ranges 0·27 to 0·31. Values are also given for pressures 2·53, 2·04, 1·40, 0·96, 0·67, and also for wires of different diameter and substance. The current density is different for the different wires, but it is found that if an "effective diameter" 0·5 mm. in excess of the actual, is used in the calculations, the current density is the same for all the four wires investigated. The effective area of a kathode is thus that of a layer 0·25 mm. thick covering it, and the current density is given by 0·4 pressure. Theoretically, the amount of gas present is shown to be sufficient to account for the current density at the kathode. J. W. P.

562. *Relation between Discharge Potential and the Absorption of Kathode Rays by Thin Sheets.* **W. Seitz.** (Phys. Zeitschr. 3. pp. 552–553, Sept. 1, 1902.)—Kathode rays are shot at an aluminium window, the ions absorbed are conducted through a galvanometer to earth giving a current i_0, those that pass through the window are caught by another conductor, and the current from this (i) is measured by an electrometer. Hence the ratio i/i_0 is found experimentally, and it is found that this is connected with the voltage V at the terminals of the tube by the formula $i/i_0 = e^{\frac{-a}{V^{5/2}}}$ a being a constant. It follows that the absorption coefficient varies inversely as $V^{5/2}$. R. S. W.

563. *Dark Space, Negative Glow and Canal Rays.* **N. Hehl.** (Phys. Zeitschr. 3. pp. 547–552, Sept. 1, 1902. From the Physikalischen Institute der Universität Erlangen.)—An investigation as to how the lengths, &c., of these depend on the pressure, current density, and size of the kathode. It is found that the kathode fall remains constant so long as the kathode itself is not wholly covered by the negative glow. Under similar circumstances the current density is independent of the area of the glow. The quotient of the current density divided by the pressure is a constant for nitrogen; for hydrogen the pressure is to be replaced by its square. When the electrode is quite covered by the glow, the voltage at the terminals is proportional to the strength of the current; the length of the canal rays increases, at first quickly, then more slowly, while the length of the dark space decreases. R. S. W.

564. *Singing Arc-flames.* **A. Masini.** (Elettricista, Rome, 11. pp. 233–236, Oct., 1902.)—The frequency does not correspond to the formula $T = 2\pi\sqrt{LC}$; the arc has a tendency to pulsations of its own period and does not appear to be a pure resistance. The law appears to be $n = D/LI$ where n is the frequency, D the electromotive force in the arc, L the self-induction, and I the strength of the current. As the pitch falls, both D and I increase, but D/I diminishes: and *vice versâ.* A. D.

565. *Decomposition of Water Vapour by Electric Sparks.* **D. L. Chapman** and **F. A. Lidbury.** (Chem. Soc., Journ. 81. and 82. pp. 1301–1310, Oct., 1902.)—When electric sparks are passed through water vapour, not only is there decomposition of the latter into its constituents, but a partial separation of the hydrogen and oxygen is also effected; the hydrogen collecting principally at the electrodes, and the oxygen chiefly in the middle. The process cannot be regarded as simply one of electrolysis, because the amount of hydrogen which is liberated is five or six times as great as that obtained in a voltameter placed in the circuit. The amount also varies with the position of the vapour inlet tube relatively to the electrodes. A. F.

566. *Reflection of Electric Waves at the End of Parallel Wires.* **H. A. Bumstead.** (Amer. Journ. Sci. 14. pp. 359–362, Nov., 1902.)—When electrical waves are sent along two straight parallel wires, and a series of stationary waves is formed by reflection from the unconnected ends of the wires, it is found that the distance from the ends to the first node for electric force is less than a quarter-wave length as determined elsewhere along the wires. This apparent discrepancy is here explained on the theories of Maxwell and Heaviside. Thus, if the wires ended normally in an infinite plate of perfect electrical conductivity, the reflection would be complete and instantaneous. When, however, this infinite plate is replaced by a simple wire bridge of perfect conductivity connecting the ends, the electric field is not instantly annulled throughout the whole plane but only in its central portion. The outlying tubes of electric force must therefore travel in toward the bridge with the speed of light, making the act of reflection more complicated, delaying the vanishing of the electric force and producing an apparent shift of the potential node beyond the bridge. When the ends of the wires are quite unconnected an entirely analogous delay occurs before the tubes of magnetic force shrink in and are annulled. Here, therefore, the current node is apparently shifted beyond the end and to about the same extent as in the other case. E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

567. *Resistance of Bismuth to Alternating Currents in a Magnetic Field.* **G. C. Simpson.** (Phil. Mag. 4. pp. 554–560, Nov., 1902.)—This continues the work referred to in Abstract No. 2379, 1901. There the effect on the resistance is represented by the "bismuth e.m.f." The present paper investigates the dependence of this e.m.f. on the field, the frequency being kept constant. The magnitude of the e.m.f. and its angle of lag behind the current are determined, the latter by the same method as in the previous paper. The angle of lag is found to be independent of the field strength. Curves are given for fields about 16,000, 12,000, 9,000, and frequencies 30, 20, and 13·3. The magnitude of the bismuth e.m.f. is found to be a linear function of the field strength, and for a field of 4,500, it is zero for all frequencies. The effect of temperature on the effect is investigated and the angle of lag is found to be independent of the temperature. The magnitude of the e.m.f. is small at −180° and +100° but increases from both points towards a maximum at −70° where it is five times greater than the value at ordinary temperatures. The whole work is summarised:—The magnitude of the e.m.f. is proportional to the current in the bismuth, is a linear function of the field strength, increases with the frequency, varies with temperature; the angle of lag of the e.m.f. varies with the frequency, is independent of the temperature and of the field strength. The magnitude of the e.m.f. at ordinary temperatures may be expressed by the empirical formula $(35 + 3{\cdot}9n)(H - 4500)10^{-8}$, n being the frequency and H the field strength. J. W. P.

568. *E.M.F. of a Thermoelectric Element.* **Ponsot.** (Comptes Rendus, 135. pp. 686–689, Oct. 27, 1902.)—By consideration of a thermoelectric element with its junctions kept at different fixed temperatures and with the e.m.f. thus produced balanced by introduction of another e.m.f. into the circuit so that no current passes, the author gives thermodynamic reasons for concluding that the specific heat of electricity in a conductor is independent of the temperature [he does not express his result quite in these terms], whence it follows that the Peltier effect π at a junction of two metals at absolute temperature θ is connected with the specific heats of electricity in the metals σ_1, σ_2 by the relation—

$$\pi/\theta + (\sigma_1 - \sigma_2)\log_e\theta = \text{const},$$

the e.m.f. at the junction being from metal 1 to metal 2. The e.m.f. in a thermoelectric circuit with one junction at a fixed temperature is thus of the form—

$$e = a\theta + b\theta\log\theta + c\,;$$

and by means of this we may measure temperatures on an exact absolute scale. The foregoing, in conjunction with Liebenow's relation, requires the specific resistance of a metal to vanish at absolute zero. R. E. B.

569. *Rotating Earth-Inductor without Sliding Contacts.* **J. J. Taudin Chabot.** (Phil. Mag. 4. pp. 506–507, Oct., 1902.)—A short description is given, with drawing: a flexible thin-wire cable, with provision for maintaining it untwisted, serves to connect the two parts into which the solenoid is divided, and replaces sliding contacts. A. D.

570. *d'Arsonval Type of Ballistic Galvanometer.* **H. Diesselhorst.** (Ann. d. Physik, 9. 2. pp. 458–467, Sept., 1902. From the Physik.-Techn. Reichsanstalt.)—The author commences by laying down the following requirements in a good ballistic galvanometer: (1) exact reading of the throw: for long throws this necessitates a period up to the end of the throw of at least 5 secs.; (2) the instrument must, after the throw, quickly come to rest; (3) the temporary loss due to the time-constant of the coil should not affect the reading; (4) great sensitiveness.

From the following general differential equation, the author analyses the condition with respect to each of the above factors:—

$$K\frac{d^2x}{dt^2} + p\frac{dx}{dt} + Dx = 0$$

when x = angle of throw, K = moment of inertia, p = moment of damping, and D = impulsive force. The general conclusion reached is that to obtain the best results the outside resistance should be such as renders the circuit nearly aperiodic, and also the time of the undamped vibrations should be about 15 secs. P. E. S.

571. *Wehnelt Interrupter and Peltier Effect.* **E. Klupathy.** (Ann. d. Physik, 9. 1. pp. 147–163, Aug., 1902. Paper read before the Hungarian Academy of Science (Class III.), May 26, 1902.)—The generally accepted explanation of the action of the Wehnelt interrupter, on the thermomechanical theory of T. Simon, is insufficient, because it does not take account of the fact that good working depends upon the direction of the current. The formation of the gaseous insulating film around the active electrode, and the subsequent piercing of that film by the spark due to the induction in the circuit, are phenomena which probably occur with either polarity. And in each case they are probably modified by the conditions of temperature and pressure at and near the active surface. When the self-induction is compensated by a suitable condenser connected between the terminals of the interrupter, the interrupter does not produce good results; this is held to confirm the hypothesis that the film is broken by the spark, and not by mere condensation, at the active surface. The author describes experiments in which the active electrode is not a point, but a short length of platinum wire the ends of which are sealed into glass tubes containing mercury. By this arrangement it is possible to heat the active surface by an independent battery. He sums up his results as follows: (1) Warming the electrode of the interrupter by a separate current increases the frequency. (2) If the wire of the anode is thin and the self-induction of the circuit is small, a condenser connected between the terminals of the interrupter increases the frequency; but if the wire is thick and the self-induction large, the condenser diminishes the frequency. (3) The heat evolved is not localised at the anode point, but is communicated to the electrolyte throughout the whole surface in contact with the electrode. An interrupter without points works much the same as one of like dimensions with the usual point. (4) The heat evolved by the Joule effect is not great enough to vaporise the electrolyte at the electrode. (5) The Peltier effect at the active surface, *i.e.*, at the separating surface between what is generally the anode and the electrolyte, is sufficiently great to cause vaporisation, and explains the fact that good working depends upon the *direction* of the current. (6) In the case of an interrupter having no wire anode, the electrolyte passing through a perforation, *i.e.*, a "Lochunterbrecher," the time of an interruption increases as the square of the area of the opening. R. A.

572. *Gases Evolved from the Wehnelt Interrupter.* **J. Nabl.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 296–304, 1902. From the Physik. Kabinet of the University of Wien.)—The author investigates the electric charges of the gases evolved by the active electrode of the Wehnelt interrupter. He refers to the work of J. S. Townsend [see Abstract No. 506 (1898)], who examined the charges in the case of normal electrolysis. The oxygen evolved at the anode, and the hydrogen at the kathode, are both found to have a positive charge. These charges increase at a greater rate as the temperature of the cell increases. If the evolved gases are free to escape into the air they become visible as a mist; the formation of this mist is taken as an indication that the evolved gases carry a charge. The author sets himself the task of calculating the mass of a mist particle from the velocity with which the cloud sinks under the action of gravity. The radius, so estimated, was found to be, in the case of positively charged oxygen, $6{\cdot}8 \times 10^{-5}$ cm. For the examination of the mist and the corresponding charges, the author uses an interrupter of special construction so as to provide a means for the collection and measurement of the gas from the active electrode. Under these circumstances, if the active electrode is the anode, a somewhat dense mist forms in the collection tube of the apparatus. If the active electrode is now made the kathode the resulting mist is not so dense. It has been proved by Voller and Walter [see Abstract No. 1728 (1899)] that in the case of the active electrode being the anode, only about one-half of the evolved gases consists of electrolytically evolved oxygen; the other half is a mixture of oxygen and hydrogen dissociated from the electrolyte by heat at the active surface. The author assumes that nevertheless the relation between the charge and the quantity of mist evolved holds good. The gases are collected in a thin metal cylinder suspended by a silk thread. The potential of the cylinder is measured by an electrometer, using the "whip" method. The charge per 1 c.c. is found to depend upon the duration of the evolution of gas. When the active electrode is the anode, if this duration is 2 minutes, the positive charge per c.c. is found to be 13×10^{-3} cm.$^{3/2}$ g.$^{1/2}$ sec.$^{-1}$. When the duration is 3 minutes the charge is 15×10^{-3} cm.$^{3/2}$ g.$^{1/2}$ sec.$^{-1}$, the increase being due to the warming of the electrolyte. If the active electrode is the kathode, the charge is still positive, but it is only about one-ninth of the above figures. The quantity of gas evolved per minute, with either polarity, was about 52 c.c. The mass of 1 c.c. of the evolved mist was found by direct weighing in a collection tube to be 17×10^{-6} grammes. An attempt was also made to determine the size of the mist particles by collecting them upon a plate of waxed glass. The diameter as indicated by a microscope micrometer was $7{\cdot}6 \times 10^{-5}$ cm. This is about half the size of the "drops" observed by Townsend for positively charged oxygen. The weight of each mist-particle, calculated from the above data, is $230{\cdot}6 \times 10^{-15}$ grammes. The charge on each particle can similarly be estimated; it works out as $2 \times 10^{-10} \times \text{cm.}^{3/2} \times \text{g.}^{1/2} \times \text{sec.}^{-1}$, which is in fair agreement with the figure given by Townsend. R. A.

ALTERNATING CURRENTS AND MAGNETISM.

573. *Magnetic Permeability of Liquids.* **F. Townsend, S. Diamant, and L. S. Thurston.** (Elect. World and Engineer, 40. pp. 811–812, Nov. 22, 1902.)—Solutions of either ferric chloride, cobalt nitrate, or nickel nitrate or chloride were placed in a glass tube 17 diameters long—which was wound with primary and secondary coils. This was placed in one arm of an induction balance, another balancing tube being filled with water, but otherwise identical. Using an interrupted current and telephone, a null method was employed similar to that in Hughes's balance, but great sensitiveness was obtained, partly by using powerful currents in the primary. Two sets of curves were plotted (1) for permeability against specific gravity, (2) permeability against percentage of pure metal in solution. The relation in each case is practically linear, as would be expected from Ewing's theory.
P. E. S.

574. *Magnetic Work in Maryland. Second Report.* **L. A. Bauer.** (Special Publication, vol. v., part 1, pp. 25–98, Nov., 1902.)—The report, mainly tabular, gives an account of the magnetic work done in Maryland in 1897 to 1901. Most of the observations were made by the author before 1899, when he took charge of the United States Coast and Geodetic Survey. Maryland now possesses the most detailed magnetic survey of any country except Holland. There is in Holland one station to every 40 sq. miles, in Maryland one to 100, in England one to 139 sq. miles; one station to every 25 or 30 sq. miles is contemplated for the whole of the United States. The average magnetic declination in Maryland is at present west, and increases at the rate of 3′ annually; the inclination decreases at the rate of 1·5′ annually; the horizontal intensity decreases annually by 0·00007 c.g.s. unit. Gaithersburg, near Washington, is in the centre of a pronounced disturbance; within 6 miles the declination varies between 0° 52·2′ W. and 8° 23·9′ W., the inclination between 71° 45·6′ and 70° 16·5′, the horizontal intensity between 0·1880 and 0·2038. In the future certain "repeat-stations" will be selected in order to ascertain whether the annual changes are, within a limited region, the same over disturbed and over undisturbed areas, and what are the limits of the region over which the annual change is of the same amount throughout the area. H. B.

575. *Magnetic Measurements in the Pamir, Summer,* 1900. **B. W. Stankewitsch.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 276–295, 1902.)—The measurements were all made with a Neumayer magnetic theodolite, which

proved very portable and accurate for the determination of the declination (mean probable error ± 40″), less so for inclination and horizontal intensity (mean error ± 4·3′ and ± 0·00085 c.g.s.). The astronomical observations are reliable within 1′. Observations were made at 29 stations, situated between latitude 37° and 41° 19′ 31″ (Taschkent, the starting-point), longitude 41° and nearly 44° E. of Pulkowa (Taschkent itself is further west, 38° 58′ 2″), and at elevations varying between 457 m. (Taschkent) and 4,650 m. (Ak Baital Pass). Abnormal values were found at Nischus, elevation 2,600 m., on the Bargang River (declination — 2° 24′ 9″) and Schunderuj, on the Murgab River, elevation 2,860 m. (intensity 0·3018). H. B.

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576. *Atmospheric Electricity.* **H. Benndorf.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 487–512, 1902. From the Physikalisch-Chemischen Institute der k. k. Universität in Wien.)—Improvements are described in mechanically registering electrometers for measurements of atmospheric electricity. Full practical details are given. The use of radium electrodes is mentioned, and is to form the subject of a later paper. A. D.

577. *Measurement of Bodies Smaller than Atoms.* **S. N. Taylor.** (Elect. World and Engineer, 40. pp. 775–777, Nov. 15, 1902.)—The author summarises and gives concise proofs of the methods of measuring the masses and velocities of the particles constituting kathode rays. References to original papers are given. W. S.

578. *Alternating Current Model.* **W. P. White.** (Phys. Rev. 15. pp. 316–318, Nov., 1902.)—A very simple and easily made model is described to illustrate how the phase-difference of a current depends on the resistance, inductance, and capacity of a circuit. The current is represented by the motion of a body which is free to move and has little inertia. Mechanical friction imitates resistance, and the inertia and tension of an elastic cord represent inductance and capacity respectively. A. R.

579. *Rotation of Electrolytes in a Magnetic Field.* **O. Urbasch.** (Zeitschr. Elektrochem. 8. pp. 559–563, Aug. 7, 1902.)—The author combats Drude's criticisms, shows that Drude had not used strong enough fields, and discusses the theory on the basis of the molecular forces involved under Nernst's diffusion theory. [See also Abstracts Nos. 1905, 1906 (1902).] A. D.

580. *Resistance of Metals, Alloys, and Dissolved Electrolytes.* **R. Mewes.** (Elektrochem. Zeitschr. 9. pp. 104–108, Aug., 1902.)—This paper is an appendix to others published in the same journal in 1902 [see Abstracts Nos. 1115 (1901) and 343 (1903)], with the object of showing that the action of the different physical forces, such as conductivity for heat and electricity, capillarity, &c., can be expressed by an equation of the form $v_n = v_o(1 + a - n\beta)^n$, or $v_n = v_o(1 - a + n\beta)^n$. In the present paper the data for mass action given in No. 104 of Ostwald's "Klassiker" are shown to be expressible by the above equations. D. H. J.

581. *Magnetostriction of Nickel-steels.* **H. Nagaoka** and **K. Honda.** Remarks on the same. **C. E. Guillaume.** (Soc. Franc. Phys., Séances, 2. pp. 41–51, 1902.)—This is materially the same work as that abstracted previously [see Abstracts Nos. 1549 and 1550 (1902)], but is more detailed in certain respects. P. E. S.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

582. *Position of Tellurium in Natural System of Elements.* **K. Seubert.** (Zeitschr. Anorg. Chem. 33. 3. pp. 246–251, Jan. 5, 1903.)—The author draws attention to recent determinations of the atomic weight of tellurium, from which it results that, in accord with previous determinations, this is really greater than that of iodine (S = 126·85). As most probable value, the average of the more reliable modern determinations is given, *i.e.*, Te = 127·6, or, taking H = 1, Te = 126·6. Tellurium is thus to be ranged *behind* iodine in the series of elements. This may be done in two different ways, according as either both elements change places, or tellurium is placed behind iodine in the gap existing in the same row and in the eighth family between the secondary groups of the light and heavy platinum metals. The former expedient seems never to have been resorted to, as this would imply the separation of iodine from the related bromine and chlorine. Those authors, however, who have been in favour of the second arrangement, have often accounted for the isomorphism between K_2TeO_4 and K_2OsO_4 by placing tellurium among the platinum metals. The author is strongly opposed to these views, the enormous and irregular differences in the melting-points, specific weights, and atomic volumes excluding any possibility of a closer relationship between these elements. As a rule, the author emphatically advises not to separate an element from a group of analogous elements, the relationship with which is shown by their similar chemical properties, and to associate it with a group of heterogeneous elements, merely on account of slight discrepancies in the atomic weight. He accordingly suggests leaving tellurium at the place corresponding to its chemical nature, using a similar indulgence as with cobalt and nickel or with argon and potassium. A. G.

583. *Tin Amalgams.* **Bakhuis Roozeboom.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 420–423, Nov. 29, 1902.)—On account of the still limited number of amalgams well investigated, the author entrusted van Heteren with a study of the properties of tin amalgams. Tin and mercury, in the liquid state, are miscible in all proportions. From the various mixtures a solid phase will separate at different temperatures. At 25° this solid phase is found by analysis to have a composition of 94 at. per cent. Sn. Because, however, of the difficulty encountered in obtaining reliable results in this way, measurements of the potential differences of amalgams of 0·001–100 at. per cent. Sn with respect to a 16 at. per cent. amalgam were also carried out, the result being that unsaturated amalgams were found to exhibit a potential increasing with the percentage of tin, until a 1·2 at. per cent. saturation is reached. Since, from this concentration up to 99 at. per cent., the potential remains unaltered, two phases of constant concentration must exist between these limits, one being the liquid phase (of 1·2 per cent.), the other containing 99 at. per cent., thus being the solid phase. The crystals separated at 25° are thus nearly pure tin, especially at the higher temperatures. From a comparison of potential differences for perfectly liquid amalgams at 25° and 50°, the heat of amalgamation is calculated. On cooling below − 34·5°, a modification is found to take place in all the amalgams of 0·3 — 85 per cent., in connection with a notable evolution of heat and a

diminution in volume. This first increases and then decreases in intensity as the concentration of the tin increases, the maximum coinciding with 50 per cent. This modification gives rise to a new solid phase being formed, which is likely to be made up of mixture crystals of a composition corresponding to the above maximum. The modification of tin present in these crystals necessarily differs from common tin. Between —24·5° and —38·5° these mixture crystals are still found to separate from the mother liquor, the volume increasing at the same time. This alteration of volume gradually diminishes with increasing percentages of tin, vanishing wholly beyond 75 per cent. At —38·6° the point of solidification of pure mercury is reached, and is found to coincide with the final point of solidification of the whole series of amalgams, containing up to 60 per cent. of tin. As the curve representative of the saturated solutions equally ends here, the solubility of tin seems to have decreased till zero at this temperature, so that instead of a eutectic mixture only the residual mercury solidifies. No conclusions are drawn as to the nature of the tin modification occurring in mixtures below —34·5°, except that its specific volume must be less than that of grey tin and greater than that of liquid, and thus of common tin.

A. G.

584. *Alloys of Aluminium.* **L. Guillet.** (Génie Civil, 41. pp. 363–365, Oct. 4; 377–382, Oct. 11; 393–396, Oct. 18; and pp. 411–414, Oct. 25, 1902.)—The alloys were prepared by Goldschmidt's method, the oxide of the metal being mixed with aluminium and the mixture fired with a cartridge of aluminium and barium peroxide. The result varies greatly according to the state of subdivision of the aluminium, the temperature reached increasing with the fineness of the metal and the weight of material used. The experiment is reasonably safe if the materials are carefully dried, but splashes must be guarded against, especially when the metal or oxide is volatile, and in the case of copper oxide it was impossible to use aluminium powder, as the mixture is dangerously explosive. The method is somewhat limited, as with a large excess of aluminium the mixture is difficult to fire and the alloy only appears in small patches in a large mass of oxide of aluminium, whilst when the oxide is present in considerable amount and yields a metal of high melting-point it is difficult to secure complete fusion. *Copper Alloys.*—Le Chatelier has indicated the existence of Al_2Cu, $AlCu_3$ and *two* compounds near to AlCu. The method now used is applicable for preparing alloys ranging from almost pure copper (a mixture in the proportions 3CuO : 2Al gives Cu 95 per cent. Al 5 per cent.) to about $CuAl_4$ (3CuO : 14Al). Compounds isolated were Cu_3Al, density 7·52, CuAl. bright, hard, needle-shaped crystals, density 5·76 and $CuAl_2$, of which prismatic needles 2 to 3 cm. long were formed in cavities on reducing relatively small masses of oxide, density 4·04. A large contraction takes place in preparing the alloys Cu_3Al and CuAl, but an expansion in preparing the alloy $CuAl_2$ from its constituents. Nitric acid immediately dissolves Cu_3Al and CuAl, but only slowly attacks $CuAl_2$ even at the boiling-point; the alloy $CuAl_2$ can be freed from the film of aluminium which covers the crystals by boiling with nitric acid until nitrogen peroxide begins to form. $CuAl_2$ is soluble in cold dilute potash and CuAl in cold, strong potash, but Cu_3Al is unacted on even at the boiling-point. In preparing the alloy CuAl a very brilliant crystalline powder was formed which was quite insoluble in aqua regia; this proved to be a double silicide of aluminium and copper (the aluminium contained 0·25 per cent. Si) and is probably identical with the *second* compound which Le Chatelier observed in alloys of this composition. *Iron alloys.* — Using the methods already described, it is not possible to fire a mixture of ferric oxide and aluminium containing more of the metal than is required to give an alloy of the formula FeAl. By heating to 800° before firing the inflammability is greatly increased, and an alloy of the composition of $FeAl_4$ can be prepared. The use of this method requires considerable caution, as the mixture is liable to explode in the furnace if the temperature reaches 1,000°. A compound FeAl was obtained in good crystalline form by firing a mixture of the composition $Fe_2O_3 : Al$, which should theoretically yield pure iron. The alloy Fe_2Al_3 was obtained in regular tetrahedra having the colour of iron and density 5·36 (calc. 4·20); an ingot of this composition (58 per cent. Fe) falls to pieces in three or four days, whilst an ingot containing 50 to 66 per cent. Fe falls to pieces in the course of a fortnight, leaving tetrahedral crystals of Fe_2Al_3 and a dull powder which can be separated by a fine sieve so that the residue has the theoretical composition; no change in weight occurs and the crumbling appears to be due to allotropic change like the crumbling of white into grey tin. All alloys made from mixtures corresponding to the formulæ between $FeAl_2$ and $FeAl_4$ give magnificent, clean, long, prismatic crystals the angles of which were measured; these have the composition $FeAl_3$, are coloured very much like aluminium, and have density 3·57 (calc. 3·56). *Manganese alloys.*—The limit of inflammability gives an alloy near $MnAl_4$; the high temperature causes the oxide to volatilise as a thick cloud of green smoke. Compounds isolated were (1) Mn_2Al_3, ingots of which crumble like those of Fe_2Al_3 in the course of twenty-four hours, leaving small brilliant crystals of the compound; (2) $MnAl_3$, a crystalline powder obtained on attempting to prepare MnAl; (3) MnAl, obtained from a mixture which should theoretically give pure manganese, was found in cavities in the ingot in the form of exceedingly hard crystals; (4) mixtures rich in aluminium, near the limit of inflammability, gave kidney-shaped masses of metal lined with needle-shaped crystals, apparently of the formula $MnAl_4$. *Chromium alloys.*—Limit of inflammability $CrAl_2$; compounds isolated Cr_4Al (density 6·75) and CrAl—brilliant silver-grey, crystalline powders. *Uranium alloys.*—U_3Al_2, exceedingly brilliant cubes: UAl_3, beautiful needle-shaped crystals. *Tin alloys.*—Prepared by firing mixtures of SnO_2 and aluminium; the action is very violent, and frequently the whole of the tin is vaporised, leaving nothing but alumina in the crucible. Gauthier has deduced from the occurrence of a maximum melting-point the existence of the compound SnAl; this has been isolated in the crystalline form and is seen in very clear crystals on etching a polished surface of the alloy and examining under the microscope. Very clean crystals of the formula $SnAl_4$ were obtained in several experiments and, unlike SnAl, were not attacked by dilute hydrochloric acid, but these could not be prepared by merely melting tin and aluminium together. All these alloys are slowly attacked by hot water. *Titanium alloys.*—The mixture of Al and TiO_2 only inflames after heating to 600°, and to obtain an ingot of alloy it is necessary to superheat the top of the mixture by means of a jet of oxygen. Compounds isolated were $TiAl_4$ and Ti_2O_3 (or possibly TiAl, analogous to SnAl). *Antimony alloys.*—Prepared by igniting a mixture of Al with Sb_2O_3 or Sb_2O_5; the mixtures are dangerously explosive. Many of the alloys decompose cold water, liberating hydrogen and antimony hydrides, and all of them crumble in the course of a few days. Gautier has deduced from the melting-point curve the existence of the compounds SbAl and $SbAl_{10}$; the former has been isolated by Wright, and the latter was obtained by the action of dilute hydrochloric acid on the kidney-shaped ingots produced in preparing an alloy of the composition $SbAl_4$; it has density 2·70 (calc. 3·16), and only decomposes water after first heating to the boiling-point. *Nickel alloys.*—After the aluminium bronzes, these are commercially the most important alloys. Alloys containing 95–50 per cent. Ni can be obtained by reducing the oxide with aluminium, though the action is always violent, and especially so when the proportion of nickel oxide is large; the remaining alloys were prepared by fusing the metals together. Compounds isolated (1) Ni_8Al (94·5 per cent. Ni), a gold-coloured, micro-crystalline alloy, density 7·37, (2) $NiAl_2$ (83 per cent. Ni), a gold-coloured alloy, exceedingly hard, which could not be reduced to powder; all alloys from 80 to 95 per cent. Ni are very hard, though malleable. (3) $NiAl_2$ (50 per cent. Ni), frequently in hexagonal, crystalline plates; an ingot of about this composition crumbles to powder leaving crystals, often sharply pointed, which can be separated with a sieve. (4) $NiAl_6$ (27 per cent. Ni) large crystalline plates, coloured like metallic tin, already described by Wöhler and Michel. (5) A crystalline powder was also obtained of the composition Ni_4Al, but this does not appear to be a uniform compound and is perhaps a eutectic mixture. Alloys containing 5–7 per cent. of nickel are distinctly harder than pure aluminium. *Cobalt alloys.*—Similar to nickel. *Silver alloys.*—A crystalline, malleable product was obtained of composition Ag_4Al_3, density 7·08 (calc. 6·80); this corresponds with a maximum in the melting-point curve. *Tungsten alloys.*—(1) The well-crystallised compound Tu_2Al possesses the remarkable property of being insoluble in boiling aqua regia. (2) The compound $TuAl_4$, already described by Wöhler and Michel, forms crystalline plates often covering 2 or 3 sq. cm. (3) The compound TuAl forms square, grooved prisms. (4) The compound $TuAl_2$ separates in needle-shaped crystals and forms a beautiful layer on the surface separating the ingot of metal from the surrounding ash of alumina; this layer can readily be knocked off. *Molybdenum alloys.*—Compounds isolated: (1) Mo_4Al, crystalline powder; (2) MoAl, minute crystals appearing in the blow-holes of the ingot; (3) $MoAl_3$, crystal plates which often make up the whole of a kilo of metal; (4) $MoAl_7$, needle-shaped crystals often forming kidney-shaped masses. *Magnesium alloys.*—Boudouard has demonstrated the existence of $AlMg_2$, AlMg and Al_4Mg [see Abstract No. 515 (1902)]. A summary is given of the commercial uses of these and other more complex alloys of aluminium. T. M. L.

585. *Mercury-trough for Lectures and a New Dialyser.* **E. Jordis.** (Zeitschr. Elektrochem. 8. pp. 675–678, Sept. 4, 1902. Paper read before the 9th Meeting of the German Electrochemical Society at Würzburg, May 10, 1902.)—A form of mercury-trough is described which is specially suited for showing the vapour pressures of liquids over mercury. The design is such that ten tubes 1 cm. in diameter can be filled and set up in the trough whilst only using 12 kilos of mercury.

The new dialyser resembles a filter-press in its general arrangement. A series of wooden cylinders, 15 cm. internal diameter, 3 cm. broad, and 2 or 3 cm. thick, are soaked in paraffin wax and covered with parchment paper. Any leaks in the paper are marked, and after drying are sealed by painting with white of egg and coagulating this by heating with a small flame. These drums, which are to hold the liquid to be dialysed, are set up in a vertical position alternately between uncovered wooden cylinders, the end cylinders are covered with sheet rubber and placed between wooden boards, the whole arrangement being clamped together with iron screws. Two holes are provided at the top of each wooden cylinder. These are available for taking samples of the liquid that is being dialysed in the drums, and are also used to admit a continuous flow of distilled water through the intermediate uncovered cylinders. T. M. L.

586. *Molecular Configuration of Phosphoryl Chloride and its Derivatives.* **R. M. Caven.** (Chem. Soc., Journ. 81. and 82. pp. 1362–1376, Oct., 1902.)—The author describes the preparation of various derivatives of phosphoryl chloride in which one, two, or three atoms of chlorine are replaced. Comparison of these compounds shows that, by the methods employed, only one such derivative containing the same substituent groups can be prepared. Hence the three chlorine atoms in phosphoryl chloride occupy similar positions in the spacial configuration of the molecule, so that the five atoms of the molecule cannot lie in one plane. It follows further that the centres of gravity of the three chlorine atoms lie at the angles of an equilateral triangle, and if an imaginary line is drawn at right angles to the plane of this triangle and through its centre, the centres of gravity of the phosphorus and oxygen atoms lie on this line. It is as yet undecided whether or not the phosphorus atom lies in the same plane as the chlorine atoms. T. H. P.

587. *Amorphous Sulphur and its Relation to the Freezing-point of Liquid Sulphur.* **A. Smith.** (Roy. Soc. Edinburgh, Proc. 24. pp. 299–301, Nov., 1902.)—When crystalline sulphur is heated above its melting-point, there is a reversible formation of amorphous sulphur, the quantity of the latter increasing as the temperature is raised; at 448° the amount of amorphous sulphur is 40 per cent. The irregularity in the freezing temperature of sulphur observed by various investigators is attributable to the formation of amorphous sulphur, which causes a depression in the freezing-point to an extent proportional to the amount of it present; the depression following Raoult's law. The mean atomic depression is 42·6. From this, and van't Hoff's law of molecular depression of the freezing-point, the molecular weight of amorphous sulphur is calculated to be S_8. A. F.

588. *Heats of Solution of Solid and Liquid Naphthalene.* **C. Forch.** (Phys. Zeitschr. 8. p. 537, Sept. 1, 1902.)—The author has obtained the following, and similar results with toluene and amyl acetate as the solvents; he proposes to try other solvents :—

Solvent.	Naphthalene dissolved.	Initial Temperature.	Final Temperature.	Temperature change for 1 gm. Naphthalene.
23·3 gm. Toluene	2·7 gm. (solid)	74·0	67·75	— 2·40°
21·3 gm. Amyl acetate	2·5 gm. (solid)	73·5	68·0	— 2·2°
20·5 gm. " "	3·2 gm. (liquid)	81·0	80·2	— 0·25°
26·9 gm. Toluene	2·5 gm. (liquid)	81·3	81·0	— 0·12°

D. H. J.

589. *Formation of Metal Oxides.* **A. Coehn** and **M. Glaeser.** (Zeitschr. Anorg. Chem. 33. 1. pp. 9–25, Nov. 18, 1902.)—One of the authors [Coehn, see Abstract No. 1376 (1898)], some time ago studied the condition of a phenomenon termed "electrostenolysis," *i.e.*, the deposition of metals in capillary pores—such as occur in clay cells, fissures of glass walls, &c.,

through which the electric current is caused to pass between two electrodes immersed in a solution of a metal salt. The following conditions were found to be required in order to obtain a reduction of metal. (1) The metal deposited cannot be dissolved by the negative radical of the salt; (2) anodically insoluble oxides or superoxides are formed; (3) the negative ion will act upon the solution, forming a higher oxide. The different behaviour of cobalt and nickel, however, was striking, only the former exhibiting the phenomenon, though no difference in the properties of the two metals was so far known as to the anodic formation of oxides. The authors, therefore, endeavoured to determine whether such a difference really exists, and they show that the difference in the anodic behaviour stated may be used to separate both metals by means of electrolysis. Studying the formation of the oxides on the curves of decomposition, the authors find that, in a slightly alcaline solution, both cobalt and nickel salts show anodic formation of oxides, cobalt sulphate at 1·21 volts, nickel sulphate at 1·30 volts, whereas in a slightly acid solution only cobalt salts will show this phenomenon (at 1·52 volts). In strongly acid solutions the formation of oxides ceases, even in the case of cobalt salts. These results are next confirmed by electrolysis in platinum vessels, and in addition to an electro-analytical method of separating cobalt and nickel, a simple electrical method of detecting the presence of cobalt in nickel solutions is given. A. G.

590. *Microscopical Detection oj Rare Earths.* **R. J. Meyer.** (Zeitschr. Anorg. Chem. 33. 1. pp. 31–45, Nov.; and 33. 2. pp. 113–117, Dec., 1902.)—After pointing out the unreliability of previous methods, the author fully discusses the microscopical method proposed by H. Behrens to test the composition of the so-called rare earths. The succinate of the earths is prepared, and a microscopic test of its crystallographic form is made. The following conclusions are drawn from the results obtained by the author. (1) The general form of the microscopic image, in the case of the cerite earths, is influenced, to a great extent, by the concentration of the solution or the relative velocity of crystallisation, several stages being frequently observed, out of which one or another will be prominent. (2) Praseodymium and neodymium succinates are not to be distinguished from one another with any certainty, when present in mixtures of both, as they will mix isomorphously. (3) The same is shown to be the case with samarium succinate, which crystallises isomorphously with didymium succinate. (4) All the cerium compounds studied proved to include some lanthanium. From these results it is inferred that microscopic tests of the succinates, though most valuable in certain cases to those who have dealt fully with all the crystallographic peculiarities as shown by the microscopic image, are not to be considered as a decisive method for judging the homogeneity of cerite earths. According to the second article the applicability of the method seems to be still more limited. A. G.

591. *Speed and Nature of Reaction of Bromine upon Oxalic Acid.* **T. W. Richards** and **W. N. Stull.** (Amer. Acad., Proc. 38. 8. pp. 321–337, Oct., 1902.)—When bromine acts on neutral oxalates, oxidation, as is well known occurs; and the authors now find that bromine also oxidises free oxalic acid, as was maintained by Wurtz but denied by Schönbein. The reaction is, however, very slow at the ordinary room temperature. Change in the concentration of the oxalic acid through a fairly wide range did not greatly affect the velocity of the reaction. Reduction of the concentration of hydrogen ions, either by neutralisation or by addition of sodium acetate, increased the velocity of reaction; while addition of strong acids retarded the oxidation. This is in agreement with the view that the reaction takes place between the bromine and the oxalate ions, as represented by the equation—

$$C_2O_4'' + Br_2 \rightleftarrows 2Br' + 2CO_2.$$

Hydrobromic acid has a retarding action, due probably to the formation of the ion Br_3', whereby the active mass of the bromine is reduced. This is supported by the fact that hydrobromic acid also greatly reduces the bromine vapour-pressure of bromine water. A. F.

592. *Velocity of Reaction of Carbon Monoxide.* **A. Smits** and **L. K. Wolff.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 493–499, Dec. 27, 1902.)—Boudouard's researches [see Abstracts Nos. 673 (1900) and 2429 (1901)] on the equilibrium $2CO \rightleftarrows CO_2 + C$, making use of the accelerating effect of the metals Ni, Co, Fe, have shown that these metals do not alter the equilibrium, their influence being limited to the velocity of the reaction, so that they act as catalysers. It, on the other hand, followed from those investigations that CO is in a metastable state below 445°. The authors undertook the present investigations with a view to determining velocities of reaction in the case of metastable states by means of catalysers. After preparing a constant catalyser (pumice-stone nickel), they go on to ascertain the order of the velocity of the above reaction, it being inferred from observations at three temperatures that the reaction is monomolecular. The points next examined are the reaction constant and the coefficient of temperature. In order to account for the results obtained, two hypotheses as to the mechanism of the reaction are suggested, viz.:—

First— I. $CO = C + O$ (with measurable velocity).
II. $CO + O = CO_2$ (with unmeasurable velocity).
Secondly—
I. $CO + Ni = C + NiO$. II. $CO + NiO = CO_2 + Ni$.

In the latter case it is not necessary to assume that either of the reactions proceeds with an unmeasurable velocity, provided the second reaction is more rapid than the first. As regards the nature of the catalyser, the authors suggest that the catalytic effect is due, not to the carbon, but to the finely divided nickel. A. G.

593. *Velocity of Reaction between Potassium Permanganate and Oxalic Acid.* **R. Ehrenfeld.** (Zeitschr. Anorg. Chem. 33. 2. pp. 117–129, Dec. 4, 1902.)—The author investigates the mechanism of the reaction between potassium permanganate and oxalic acid. It was inferred from Harcourt and Esson's experiments (Phil. Trans., London, 1865, p. 193) that this might be a polymolecular reaction of the first order, *i.e.*, that the differential equation representative of the behaviour under variable conditions of mass is of the first order. This is indeed shown to be the case by the numerical results of this paper, as the logarithmic expression used to calculate the coefficient of velocity yields numbers of a fairly satisfactory constancy. Measurements were made by introducing a known volume of oxalic acid solution of a given percentage in a previously dried bottle with a ground-in glass stopper, and heating it in an Ostwald's thermostat with toluol regulator up to a temperature of 20·3°. At a given moment the volume of a titrated potassium permanganate solution was added, containing the equivalent amount of this substance, as derived from the equation—

$$8C_2H_2O_4 + 2KMnO_4 = K_2C_2O_4 + 2MnC_2O_4 + 10CO_2 + 8H_2O.$$

The reaction was interrupted at a given moment by adding a sufficient amount of potassium iodide solution previously acidified. In spite of these satisfactory results, it was considered desirable to answer the question of the order of the reaction also from another point of view, as external perturbations might easily have influenced the results of a single series of experiments. This second method is the one suggested by van't Hoff, starting from several series of experiments with unequal initial concentrations, and comparing such coefficients of velocity as are relative to the same state of the reaction. The results fully warrant the conclusions drawn from the first method. A. G.

594. *Transformation of Polymorphous Substances.* **J. Meyer.** (Zeitschr. Anorg. Chem. 33. 2. pp. 140–149, Dec. 4, 1902.)—Polymorphous modifications are known to be capable of being converted into one another, the one form stable under given conditions being always formed from the unstable ones, though with a frequently minimum velocity. In order to test some relations derived from thermodynamic considerations, the author tests the behaviour of monoclinic and rhombic sulphur in different solvents and at different temperatures. Sulphur, in fact, is readily obtained in both modifications, the velocity of transformation being always a limited one. The results derived from these experiments are as follows: 1. It is shown that monoclinic sulphur is more soluble in chloroform, benzol, and ether than rhombic sulphur. 2. The ratio of both solubilities is constant at a constant temperature; it is furthermore independent of the solvent. 3. The natural logarithm of the quotient of the solubilities practically agrees with the value calculated from the heat of conversion. A. G.

595. *Benzidine Reaction.* **J. Potter van Loon.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 423–424, Nov. 29, 1902.)—The author investigates the reaction of hydrazo-benzol, which, on being treated with a diluted mineral acid, is known to pass into benzidine and diphenyline, the former being the product essentially formed. The points considered are the ratio of the isomerics, the dependence of this ratio on temperature and concentration of acids, and the velocity of reaction under given conditions. At ordinary temperatures, hydrochloric acid of a concentration 0·1 normal is found to yield 84 per cent. of benzidine, whereas normal hydrochloric, as well as bromhydric acids, will yield 90 per cent. At higher temperatures this ratio is altered, the percentage of benzidine formed being materially lower. In order to obtain some data as to the velocity of reaction, the author placed a beaker containing 50 per cent. alcohol and hydrochloric acid of the concentration 0·1 normal in a thermostat. Carbonic acid gas was then passed through it, and hydrazo-benzol was added to the liquid, dissolving but a small proportion of the precipitate. At 25° the velocity of reaction proved to be dependent on the concentration of the acid, and to increase more rapidly than the latter. Further experiments on the same line are in progress. A. G.

596. *Complex Mercury Salts.* **R. Abegg** [with **C. Immerwahr** and **Jander**]. (Zeitschr. Elektrochem. 8. pp. 688–690, Sept. 4, 1902. Paper read before the 9th meeting of the German Electrochemical Society at Würzburg, May 10, 1902.)—The solubility of mercuric salts is increased by the addition to the bromide, iodide, sulphocyanide, or sulphide of the corresponding alkali salts; this is owing to the formation of a complex anion, *e.g.*, $KBr + HgBr_2 \rightleftharpoons K \mid HgBr_3$, and the increase of solubility is proportional to the extent to which the complex is formed. Insoluble mercurous salts are partially decomposed into mercury and mercuric salts, $Hg_2Br_2 \rightleftharpoons Hg + HgBr_2$, and so show a similar behaviour; they may, in fact, be treated as if they were sparingly-soluble allotropic forms of the mercuric salts. The solubility of $HgBr_2 = 0{\cdot}017$ mols. per litre, and that of $HgI_2 = 0{\cdot}0001$ mols. per litre; that of Hg_2Br_2 and Hg_2I_2 is too small to be easily determined; the increases of solubility are as follows:—

KBr.	Increased solubility of $HgBr_2$.	KI.	Increased solubility of HgI_2.
0·1N	0·071	0·1	0·0492
0·5	0·342	0·25	0·131
0·866	0·594	0·5	0·266
2·0	1·39	1·0	0·549
3·0	2·08		

KBr.	Increased solubility of Hg_2Br_2.	KI.	Increased solubility of Hg_2I_2.
1·0	0·00805	0·04	0·00196
1·5	0·0176	0·1	0·0095
2·0	0·0343	0·5	0·118
3·0	0·0783	1·0	0·213

Allowing for the lesser solubility of the iodides, it is calculated that the iodides have 100 times as great a tendency to complex formation as the bromides, whilst in the case of the silver salts the ratio is 200 : 1, and in the case of the cuprous salts 1400 : 1. T. M. L.

597. *Silicic Acid and the Silicates of the Alkalis and Alkaline Earths.* **E. Jordis** [with **E. H. Kanter**]. (Zeitschr. Elektrochem. 8. pp. 678–684; Discussion, p. 684, Sept. 4, 1902. Paper read before the 9th meeting of the German Electrochemical Society at Würzburg, May 10, 1902.)—Graham states that solutions of pure silicic acid can be obtained which, when concentrated by boiling, contain up to 16 per cent. SiO_2, but are coagulated by exposure to air or by a few bubbles of carbon dioxide; other observers have obtained only less concentrated solutions which in some cases were coagulated by ammonia, but not by carbon dioxide. As a matter of fact, the solubility of pure silicic acid appears to be very small, but is very largely increased by either acid or alkaline impurities. A solution of sodium silicate mixed with hydrochloric acid is free from chlorine after eight to ten days, but still contains sodium, which only disappears after six weeks; the solution then contains 1½ per cent. SiO_2 and is coagulated neither by acids nor alkalis, but cannot be concentrated by boiling; by dialysing for eight weeks the solubility was reduced to 0·6 per cent., but was increased to 4 per cent. by adding a small amount of acid or alkali. Further dialysis of the 1½ per cent. solution causes the separation of a flocculent precipitate, the filtrate from which contains only 0·05 per cent. SiO_2; similarly when this very pure precipitate is boiled with water it only dissolves to the extent of 0·05 per cent. These are regarded as the upper limits of solubility and the author concludes that pure silicic acid is not soluble to a greater extent than 1 mol. in 100 litres, that the colloidal form of silicic acid does not exist, and that the supposed colloidal form has always consisted of acid or basic salts of silicon hydroxide. Evidence is given for the existence of acid-derivatives of silicic acid, especially a compound containing about 1 HCl : 30 SiO_2; this is stable at a red head, but is decomposed by boiling with water. Sodium silicate appears to be hydrolysed in accordance with the equation—

$$2Na_2SiO_3 + H_2O \rightleftharpoons 2NaOH + Na_2S_2O_5\,;$$

the whole of the silica passes through a membrane and colloidal acid is not produced. The insoluble silicates of the alkaline earths are decomposed in a similar way; successive extracts contain a larger and larger proportion of alkali to silica, until ultimately a residue of insoluble silica, free from alkali, is left. T. M. L.

598. *Change of Trimethylene into Propylene.* **S. Tanatar.** (Zeitschr. Phys. Chem. 41, pp. 735–738, Sept. 26, 1902.)—The author has already shown that the transformation of trimethylene into propylene occurs at 600° C. He now shows that the change occurs even at the ordinary temperature in presence of platinum black. At 100° from 40 to 45 per cent. of the gas was transformed in 120 hours. D. H. J.

599. *Decomposition of Di-Azonium Salts.* **H. Euler.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. 59. No. 7. pp. 227–237, Sept., 1902.)—Phenolic scission of di-azonium salts in aqueous solution has to be considered, according to the experiments recorded in this paper, as a decomposition of the di-azonium salt itself, and not of a di-azo compound. In aqueous alcoholic solution of di-azonium salts, even very slight amounts of free acid will alter both the character and rate of decomposition. The temperature coefficient of phenolic scission in aqueous solution was measured on two salts; it may be inferred that this coefficient for different salts diverges but very slightly. Colloidal platinum exerts catalytic effects on phenolic scission. Out of the substituents in the benzol nucleus, CH_3, COOH, OCH_3, Cl and Br, all—excepting CH_3 in *o*- and *m*-position—are shown to lower the velocity of this reaction. Exposure to light does not seem to have any influence. A. G.

600. *Colloidal Solutions.* **R. Zsigmondy.** (Zeitschr. Elektrochem. 8. pp. 684–687, Sept. 4, 1902. Paper read before the 9th meeting of the German Electrochemical Society at Würzburg, May 10, 1902).—Colloidal solutions include all stages of subdivision from that at which particles can be seen under the microscope to solutions having a definite osmotic pressure and power of diffusion. Jointly with H. Siedentopf, the author has devised a microscopic method of determining the size of the particles in such solutions, even when the separate particles cannot be seen. The first results given deal with ruby glass, in which the colour is due to minute particles of metallic gold. A colourless glass showing only a slight cloudiness contained particles about equal in diameter to a wave-length of light, a second sample, having particles about ⅓ wave-length in diameter, showed a very slight ruby colour, but a very marked cloudiness; a third sample, showing a beautiful red colour, contained particles about 20×10^{-6} mm. in diameter, whilst an intensely-coloured ruby glass contained particles of about half this diameter; finally, a violet glass with blue and red streaks also contained particles about 10×10^{-6} mm. in diameter. Colloidal gold solutions contain similar particles, but whilst the larger particles are quiescent, the smaller have a very vigorous motion; the smallest visible particles move in $\frac{1}{8}$ to $\frac{1}{4}$ sec. through 100 to 1,000 diameters, and also oscillate with a much shorter period; this motion, if the solution is permanent, lasts for months. Observations with other colloidal solutions are also described. T. M. L.

601. *Equilibrium Phenomena in Precipitation Reactions, III.* **F. W. Küster** and **A. Thiel.** (Zeitschr. Anorg. Chem. 33. 2. pp. 129–140, Dec. 4, 1902.)—The authors some time ago stated the presence of isomorphously mixed precipitates of silver halogen salts, when precipitating mixed halogen salt solutions with silver ions, these precipitates being in equilibrium with the residual solution. Silver electrodes in contact with these systems will take potentials dependent upon the solubility of the precipitates, varying according to composition. As in previous researches the ratio of the various halogens in the precipitate and in the solution was always a very different one, the authors now proceed to test a case where equal ratios are to be expected, *i.e.*, mixtures of silver rhodanide and bromide, the solubility of both silver salts being as equal as possible in this case. The precipitates would be kept in permanent suspension by means of a constantly working agitator, until the potentials of the silver electrodes immersed in the solution remained constant for some time, when both the solution and the precipitate were analysed, and the potential noted; from the potential, the concentration of the silver ions was calculated in a well-known way. It results from these experiments that when precipitating mixed solutions of various composition of rhodanides and bromides with silver solutions, isomorphous mixtures (viz., solid solutions) of silver rhodanide and bromide are always formed. The mixtures form an incomplete series with about 0–8 and 90–100 molecular per cent. of silver bromide. Precipitates of intermediate composition are mixtures of reciprocally saturated final mixtures. The solubility of silver rhodanide is $1{,}08 \cdot 10^{-6}$ (the solubility of silver chloride being $1{,}41 \cdot 10^{-5}$, that of silver bromide $8 \cdot 08, 10^{-7}$). A. G.

602. *Equilibrium between Maltose and Dextrose.* **C. Pomeranz.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2b. pp. 554–557, 1902. From the Chemical Laboratory of the University of Vienna.)—According to the law of mass action the equilibrium established by Croft Hills between maltose and dextrose in presence of an enzyme should be determined by the equation $C^2/c = k$ where $C =$ concentration of dextrose, $c =$ concentration of maltose. The values of k in five of Croft Hills's experiments were calculated to be 20·9, 19·8, 18·4, 21·3, and 20·1, mean 20·3. It is further deduced from the small difference between the heat of combustion of dextrose and maltose that this constant is practically independent of the temperature. T. M. L.

603. *Solubility of Salts of Optically-Active Monobasic Acids.* **C. Pomeranz.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2b. pp. 551–553, 1902. From the Chemical Laboratory of the University of Vienna.)—Assuming the law of mass-action to hold good for electrolytic dissociation (an assumption that is still unproved for highly ionised electrolytes), it is deduced that the solubility of a mixture of the *d* and *l* salts of an optically active monobasic acid is given by the equation $L = l(2(1 - \alpha) + \sqrt{2}\alpha)$ where l is the solubility of the optically active salts separately and α their degree of dissociation. Using this equation, the solubility of a mixture of silver *d*- and *l*-valerates is calculated to be 1·10 g. per 100 g. H_2O at 20° C., whilst Sedlitsky has found 1·177. This result confirms the accuracy of the above formula and also serves to establish the identity of inactive silver methylethylacetate with *d* + *l* silver valerate. T. M. L.

604. *Studies in Inversion. II.* **C. Kullgren.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. 59. No. 9. pp. 817–825, Nov., 1902.)—In his paper on temperature variations of the velocity of reaction, Arrhenius points out that the influence of temperature cannot be explained on kinetic principles. As regards the velocity of inversion, he makes use of the well-known hypothesis that cane-sugar is, to a small extent, composed of active molecules, the number of which largely increases with increasing temperature. The author shows that the change in the velocity of reaction with temperature may be, for the most part, reduced to a corresponding alteration in the dissociation conditions of the reacting bodies. Whenever the degree of dissociation is but slightly altered by variations of temperature, the increased mobility of the ions, however, is likely to exert a relatively much higher influence. A thermodynamic theory of these phenomena is finally given. [See also Abstract No. 1202 (1899)]. A. G.

605. *Constitution of Salts.* **R. Kremann.** (Zeitschr. Anorg. Chem. 33. 1. pp. 87–96, Nov. 18, 1902.)—The author ascertains the constitution of some salts by means of migration tests. Cobalt amine salts are, according to Werner's theory, made up of a system of six atoms, radicles or molecules, grouped round a hexavalent cobalt atom, so as to form a "first sphere," the remaining atoms or radicles forming a "second sphere," capable of being ionised, whereas the cobalt atom with the former six atoms, radicles or molecules, represents a complex ion. This theory is directly confirmed by a migration test as indicated by Nernst. In the case of methyl orange, it is shown by a similar experiment that no measurable amount of kathions is formed in a strongly acid solution; the author accordingly infers that this salt should not be considered as an amphoterous electrolyte. The case next studied is the one of the salts of a cupro-phosphorous acid, the existence of which is confirmed in the reaction of copper salt solutions, to which some grams of phosphorous acid is added, with sodium hydroxide. The author finally tests some alkaline solutions of chromium and zinc hydroxide, the opinion enunciated by Fischer and Herz that these hydroxides are colloidally dissolved in the alkali, turning out to be erroneous. A. G.

606. *Conductivity of Solutions at Low Temperatures.* **J. Kunz.** (Comptes Rendus, 135. pp. 788–790, Nov. 10, 1902.)—Measurements were made of the conductivity of aqueous solutions of sulphuric acid at temperatures between 0° and −74°. The following values were obtained :—

19·1%		32·66%		42·05%		50·86%		60·90%		63·76%	
t	$10^{3}k$	t	$10^{3}k$	t	$10^{3}k$	t	$10^{3}k$				
0	519	0	500	0	447	0	357	0	232	0	193
− 5·7	478	− 9·4	398	− 10·9	335	− 10·5	270	− 10·5	171	− 10·2	143
− 10·7	370	− 14·2	342	− 20·5	261	− 20·6	194	− 20·3	124	− 20·2	102
− 15·2	266	− 19·8	301	− 28·3	203	− 28·6	140	− 33·4	71·8	− 28·6	71·9
− 18·4	194	− 34·1	168	− 59·5	28	− 49·1	39·2	− 51·9	19·4	− 56·1	5·87
		− 44·6	66	− 74·3	4·7	− 66·1	4·6	− 69·9	1·31	− 65·9	0·66

It will be seen that although the conductivity decreases rapidly as the temperature falls, the rate of decrease also diminishes, so that the conductivity, instead of becoming zero at −89° as Kohlrausch has suggested [see Abstract No. 524 (1902)], actually persists at the lowest temperatures reached. The conductivity temperature curves instead of cutting the axis of temperature (as would appear from their behaviour above 0°) in reality swerve aside and approach this axis asymptotically. T. M. L.

607. *Electric Conductivity and Viscosity of Solutions of Casein.* **O. Sackur.** (Zeitschr. Phys. Chem. 41. pp. 672–680, Sept. 26, 1902. From the Beitragen zur Chemischen Physiologie und Pathologie.)—By tritrating casein, in presence of phenol phthalein as indicator, with sodium, calcium or barium hydrate, the author found the equivalent of casein to be 1185. To arrive at the molecular weight it was next necessary to ascertain the basicity of casein; this was done by Ostwald and Walden's method of examining the change of conductivity of the salts (sodium and ammonium) with change of concentration. The results point to tetrabasicity (possibly to penta- or hexa-basicity) for casein and a consequent molecular weight $= 4 \times 1185$; this value may be compared with that given by Hedin, Blum, and Vaubel, viz., 6,600, from a consideration of the decomposition products. The low values found for the equivalent conductivities pointed to a small velocity of migration of the casein anion, and it was of interest to know whether so large and slow a molecule could pass through a membrane. It was ascertained that, though the sodium casein salt is an electrolyte, it does not diffuse through parchment. The viscosity of solutions of the sodium salt was found to be due, not to the free casein produced by hydrolysis, but chiefly to the sodium salt or its ion; the values for the viscosity were in accordance with Arrhenius's empirical formula, $\eta = A^n$, although the values of A are in the present case of quite a different order from any hitherto known. The paper closes with a short study of isocasein. D. H. J.

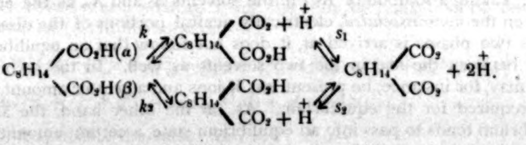
608. *Liquid Cells.* **Berthelot.** (Comptes Rendus, 134. pp. 933–950, April 28; 1009–1030, May 5; 1461–1478, June 23; and 135. pp. 129–133, July 21, 1902.)—A series of measurements on liquid cells is given, more particularly with reference to the possibility of such cells playing a part in physiological phenomena. The e.m.f. was measured of a large number of cells having different concentrations of a salt at the poles, or a neutral, acid, or alkaline solvent with an oxydant such as H_2O_2 at one pole, and a reducing agent such as pyrogallol at the other pole, or an acid opposed to a base, &c. The cells were of high resistance with platinum wire electrodes. The neutralisation of a salt and similar reactions give an e.m.f. up to 0·6 volt. Such cells, however, when placed in series do not give appreciable electrolysis of water. If, on the other hand, an oxydant is added to one pole and a reducing agent to the other, effective electrolysis takes place. Other cases of this kind are noted. The author considers the velocity of the reactions and their increase by an auxiliary reaction so as to render electrolysis possible.

W. R. C.

609. *Progressive Dissociation of Dibasic Acids.* **R. Wegscheider.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2b. pp. 441–510, 1902. From the Chemical Laboratory of the University of Vienna.)—The dissociation of dibasic acids takes place in two stages, *e.g.*, $H_2SO_4 \rightleftarrows \overset{+}{H} + H\overset{-}{S}O_4$, and $H\overset{-}{S}O_4 \rightleftarrows \overset{+}{H} + \overset{--}{SO_4}$, and each stage has its own dissociation constant, *k* or *s*, at least in the case of acids weak enough to obey Ostwald's dilution law. Hitherto the second dissociation constant has only been determined for acid salts, *e.g.*, $KHSO_4 \rightleftarrows \overset{+}{K} + H\overset{-}{S}O_4$, and $H\overset{-}{S}O_4 \rightleftarrows \overset{+}{H} + \overset{--}{SO_4}$, the concentration of the hydrogen ions being deduced from the velocity of inversion of cane-sugar (Smith). In the case of symmetrical dibasic acids the second dissociation constant can be approximately determined from the conductivity measurements; for this purpose it is necessary to deduce the first dissociation constant from the conductivity in moderately concentrated solutions, and to calculate the probable values of the mobilities of the univalent and divalent anions from the number of atoms they contain. The following table shows the values deduced for a number of symmetrical dibasic acids:—

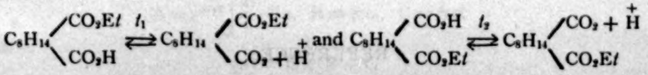
Name and Formula of Acid.		Dissociation Constants.	
		10^6k.	10^6s.
Diglycollic acid	$O(CH_2 . CO_2H)_2$.........	1,100	37
Thiodiglycollic acid	$S(CH_2 . CO_2H)_2$	480	33
Dithiodiglycollic acid	$S_2(CH_2 . CO_2H)_2$.........	650	52
Sulphodiacetic acid	$SO_2(CH_2 . CO_2H)_2$	13,000	475
a-Sulphodipropionic acid	$SO_2(CHMe . CO_2H)_2$...	10,100	364
Suberic acid........................	$C_6H_{12}(CO_2H)_2$............	31	3
Azelaic acid	$C_7H_{14}(CO_2H)_2$	30	4
Malonic acid	$CH_2(CO_2H)_2$	1,580	10
Benzalmalonic acid	$C_6H_5 . CH . C(CO_2H)_2$	4,080	3
Dibenzylmalonic acid	$(C_6H_5 . CH_2)_2C(CO_2H)_2$	41,000	19
Chloromalonic acid	$Cl . CH(CO_2H)_2$.........	40,000	194
Tartaric acid, dextro	$CHOH . CO_2H$ .... $\vert$ $CHOH . CO_2H$	970	45
" " lævo...............		970	42
" " racemic		970	40
Maleic acid	$CH . CO_2H$ $\Vert$ $CH . CO_2H$..............	11,700	8
Fumaric acid	$CH . CO_2H$ $\Vert$ $CO_2H . CH$	930	29
3 : 6. Dichlorophthalic acid ...	$C_6H_2Cl_2(CO_2H)_2$	34,000	280

In the case of unsymmetrical dibasic acids, such as camphoric acid, the phenomena are more complex, and four dissociation constants, k_1, k_2, s_1, s_2, may be determined corresponding with equations such as—



$$C_8H_{14}\begin{matrix}\nearrow CO_2H(\alpha)\\ \searrow CO_2H(\beta)\end{matrix}\begin{matrix}\overset{k_1}{\rightleftharpoons} C_8H_{14}\begin{matrix}\nearrow CO_2+\overset{+}{H}\\ \searrow CO_2H\end{matrix} \overset{s_1}{\rightleftharpoons}\\ \underset{k_2}{\rightleftharpoons} C_8H_{14}\begin{matrix}\nearrow CO_2H\\ \searrow CO_2+\overset{+}{H}\end{matrix} \underset{s_2}{\rightleftharpoons}\end{matrix} C_8H_{14}\begin{matrix}\nearrow CO_2\\ \searrow CO_2\end{matrix}+2\overset{+}{H}.$$

These constants are not independent, but $k_1 s_1 = k_2 s_2$, and the probable value of the ratio $s_1/s_2 = k_2/s_1$ may be deduced from the ratio of the dissociation constants l_1 l_2 of the ester-acids



$$C_8H_{14}\begin{matrix}\nearrow CO_2Et\\ \searrow CO_2H\end{matrix} \overset{l_1}{\rightleftharpoons} C_8H_{14}\begin{matrix}\nearrow CO_2Et\\ \searrow CO_2+\overset{+}{H}\end{matrix} \text{ and } C_8H_{14}\begin{matrix}\nearrow CO_2H\\ \searrow CO_2Et\end{matrix} \overset{l_2}{\rightleftharpoons} C_8H_{14}\begin{matrix}\nearrow CO_2+\overset{+}{H}\\ \searrow CO_2Et\end{matrix}$$

As a first approximation, the unsymmetrical acids are treated in the same way as the symmetrical acids and values deduced for *k* and *s*; then, if the necessary data are available for determining the ratio $s_1 : s_2 = k_2 : k_1$, the four constants are deduced from the equations $k = k_1 + k_2$, $\frac{1}{s} = \frac{1}{s_1} + \frac{1}{s_2}$. Values deduced in this way are given for seventeen unsymmetrical dibasic acids, of which the most important are given in the following table :—

Name and Formula of Acid.		10^6k.	k_1/k_2.	10^6s.	10^6s_1.	10^6s_2.
Malic acid	$CO_2H . CHOH . CH_2 . CO_2H$	395	3·64	7·5	9·5	35
Chlorosuccinnic acid	$CO_2H . CHCl . CH_2 . CO_2H$	2,840	14·5	36	38	560
Bromosuccinnic acid	$CO_2H . CHBr . CH_2 . CO_2H$	2,780	10·4	39	43	440
3-Nitrophthalic acid	$C_8H_3(NO_2)(CO_2H)_2$	12,200	7·6	40	45	340
4-Nitrophthalic acid	$C_8H_3(NO_2)(CO_2H)_2$	7,700	1·15	40	75	86
Hydroxyterephthalic acid	$C_8H_3(OH)(CO_2H)_2$	2,500	11·4	45	49	560
Bromoterephthalic acid ...	$C_8H_3Br(CO_2H)_2$	6,200	12	76	82	990
Nitroterephthalic acid......	$C_8H_3(NO_2)(CO_2H)_2$	18,700	17·9	200	210	4,400

The s_2 for nitroterephthalic acid reaches a value 0·0444, which is almost equal to the dissociation-constant of *o*-nitrobenzoic acid ; an ion in which the less strongly acid group is dissociated and the more strongly acid group undissociated would therefore be in a very unstable condition. By comparing the second dissociation-constant with that of an analogous monobasic acid the author deduces a factor showing the influence of the substitution of the ionised group $-\underline{CO}_2$ on the dissociation-constant of a monobasic acid ; the average value of the factor is 0·63, and the introduction of this group therefore reduces the dissociation by about one-third. T. M. L.

610. *Potential Difference at Limiting-Surface of Two Solvents.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 485–493, Dec. 27, 1902.)—It has been shown by Nernst that at the limiting-surface of two liquids forming two different layers, as, for instance, water and phenol, a p.d. is produced, on account of the unequal distribution of the neutral molecules and ions of the same dissolved electrolyte. Though a direct determination of this potential difference seems as yet impossible, the author goes on to give the exact theory of the phenomena, the more so as recent researches have dealt with them indirectly. This theory is based on the following considerations : Taking a solution of KCl in the solvents A_1 and A_2, as the equilibrium between the *non-dissociated*, electrically neutral portions of the dissolved KCl in the two phases is arrived at, it does not follow that an equilibrium state exists between the *ions* in the two solvents as well. In the second solvent there may, for instance, be present less K-ions and a greater amount of Cl-ions than required for the equilibrium. As, on the other hand, the absence of equilibrium tends to pass into an equilibrium state, a certain amount of K-ions passing from A_1 towards A_2 will settle in the limiting layer of A_2, whereas the correspondingly liberated Cl-ions will remain in the limiting layer of A_1. This process gives rise to an *electrical double layer*, and accordingly a *potential difference* is produced. A. G.

REFERENCE.

611. *A Review of Some of the Recent Literature of the Periodic Law.* **R. H. Bradbury.** (Frank. Inst., Journ. 154. pp. 283–290, Oct., 1902.)